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Nutrient Criteria Technical Guidance Manual

Lakes and Reservoirs

First Edition



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As with any prototype technical guidance, differences about methods and approaches are to be expected. This and subsequent guidance manuals for other water body types are not intended to be singular, one-time publications. As experience accumulates, future editions will be prepared. Suggestions not presently incorporated may be revisited and appear in later versions.

Disclaimer

This manual provides technical guidance to States, Indian Tribes, and other authorized jurisdictions to establish water quality criteria and standards under the Clean Water Act (CWA), to protect aquatic life from acute and chronic effects of nutrient overenrichment. Under the CWA, States and Indian Tribes are to establish water quality criteria to protect designated uses. State and Indian tribal decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. While this manual constitutes EPA's scientific recommendations regarding ambient concentrations of nutrients that protect resource quality and aquatic life, it does not substitute for the CWA or EPA's regulations; nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, Indian Tribes, or the regulated community, and might not apply to a particular situation or circumstance. EPA may change this guidance in the future.

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Executive Summary

Overenrichment of surface waters in the United States has been a long-standing problem to the extent that approximately half of the waters reported by the States to be impaired are attributed to excess nutrients and related biological growth. The EPA has established the National Nutrient Criteria Program to address this water quality problem. The surface waters of concern are lakes and reservoirs, streams and rivers, estuaries and coastal marine waters, and wetlands. Criteria representing enrichment conditions of surface waters that are minimally impacted by human developmental activities will be developed for each of the regions of the country. These will then become the basis for States and Tribes of the United States to develop nutrient criteria to protect the designated uses of those waters. This manual is designed to help accomplish this for lakes and reservoirs.

Nitrogen and phosphorus are the primary causes of overenrichment and are obvious nutrient criteria variables, but biological response variables are also important in addressing the consequences of overenrichment.

Limnologists and lake managers have developed a general consensus about freshwater lake responses to nutrient additions, that essentially an ambient total phosphorus (TP) concentration of greater than about 0.01 mg/L and or a total nitrogen (TN) of about 0.15 mg/L is likely to predict blue-green algal bloom problems during the growing season. Similarly, chronic overenrichment leads to lake quality degradation manifested in low dissolved oxygen, fish kills, algal blooms, expanded macrophytes, likely increased sediment accumulation rates, and species shifts of both flora and fauna.

However, because some parts of the country have naturally higher soil and parent material enrichment and different precipitation regimes, the application of that general consensus approach has to be adjusted by region. Therefore, an ecoregional and reference condition approach is necessary to develop nutrient criteria appropriate to each of the different geographical and climatological areas of the country. Initially, the continental United States has been divided into 14 separate ecoregions of similar geographical characteristics, and criteria will be developed for each.

While additional variables may be used as nutrient criteria, the initial effort will concentrate on TP, TN, algal chlorophyll, and Secchi depth or similar measure of algal turbidity to reflect the primary production response to overenrichment. Thus, the criteria involve four basic indicators of overenrichment. Other indicators, such as dissolved oxygen (DO) and macrophyte growth or speciation, and other flora and fauna changes are also deemed useful, but the first four are paramount, especially the two limiting nutrients. Throughout the country, cultural eutrophication (or overenrichment) is largely caused by either too much N or P or some combination of the two in their various forms. Nitrogen may not be critical to many fresh water lakes, but it does become significant in estuaries and coastal waters downstream. An essential part of the process for developing nutrient criteria is to pay attention to downstream effects. Therefore, nitrogen as well as phosphorus reduction for lakes is needed to benefit the lower reaches of the overall system.

TN and TP are described as causal variables, and chlorophyll and algal turbidity are initial response variables. Measuring just the response variables clearly shows the existence of a problem, but waters with a short retention time could look clear and be aesthetically acceptable, and could still be sending an unacceptable load of N and P downstream to be someone else's problem. This is why EPA expects downstream effects to be considered as part of the nutrient criteria development process.

Nutrient criteria development consists of five elements:

1. Historical data and other information to provide an overall perspective on the status of the resource.
2. Present reference sites and their collective reference condition describing the current status.
3. Modeling to refine data implications and analysis above if necessary.
4. Objective assessment of all of the above information by the States and by the EPA Regional Technical Assistance Groups (RTAGs), a board of State and Federal specialists established in each EPA Region to help develop and administer the National Nutrient Criteria Program, to establish the ecoregional criteria, and to review proposed State or Tribal nutrient criteria.
5. Attention to downstream consequences before the criterion is finally established.

Using this approach, EPA ecoregional benchmark criteria can be established that States and Tribes can use to help set their own criteria to protect all their designated uses. A key responsibility of the RTAGs, with their best knowledge of regional water quality and management potential, is the development of these ecoregional criteria and review of subsequent State and Tribal criteria. A summary of the procedural approach for ecoregional criteria development is as follows:

The RTAGs collect as much existing reference quality data for at least the four principal variables as possible from STORET, States and Tribes, universities, local governments, and other Federal agencies. Data collection is directed to the particular waterbody type of interest and to established physical classes of those waters, e.g., small, medium, and large volume lakes. Because the States are all represented on the RTAG, they are fully involved in the process.

- The data are reviewed for quality and utility and then the distribution of data points throughout the ecoregion for each class is assessed and additional data gathered if needed.
- When satisfied with the adequacy of the data distribution for the classes, the reference sites within each ecoregion are compared. If there are obvious shifts in reference values (e.g. through cluster analysis) the ecoregion is subdivided accordingly or perhaps boundaries are shifted. The same assessment should be made for temporal distribution to determine if seasonal criteria are needed. Both of these divisions should help reduce variability in the reference condition as well, albeit with the risk of reducing the population of applicable observations.
- In the process, the RTAGs are expected to coordinate with their adjacent counterparts to promote consistent subregional boundaries and criteria. The EPA Headquarters nutrient criteria group will play a mediating and coordinating role in this process, but the initial determinations will be made by the RTAGs.
- The established reference conditions will then be incorporated with the other elements of criteria development—historical perspective, possible modeling of data, and concern to protect downstream waters—by the RTAG to set that particular ecoregional criterion for TP, TN, chlorophyll *a*, and Secchi depth or similar measure of organic based turbidity.

These ecoregional criteria would typically serve as the basis for proposing and promulgating a water quality standard when a State or Tribe fails to adopt an acceptable standard. EPA expects the States and Tribes of the Continental United States to develop nutrient criteria for each class of surface water bodies within three years of the establishment of the ecoregional criteria for those waters. It should be noted that States and Tribes may elect to establish their criteria using methods other than those described in these EPA guidance manuals. EPA promotes such flexibility so long as the proposed alternative is:

- Based on a scientifically defensible approach
- Contains sufficient parameters to address nutrient overenrichment causes and responses, i.e., consistent with the variables designated by EPA and with the five nutrient criteria elements listed above
- Protects and maintains downstream water quality sufficient to preserve the beneficial uses of those waters. In addition to criteria to protect the uses, States must adopt antidegradation policies and procedures to protect and maintain existing water quality.

Hawaii, Alaska, and U.S. Trust Territories will develop separate ecoregions in conjunction with their RTAGs and the National Nutrient Criteria Program.

This manual concludes with chapters describing data models, and management options available to the States and Tribes to actively protect or restore their lake resources. Case histories illustrating nutrient criteria development and management efforts are also appended with the names of individual specialists to contact for more information.

Editorial Note

Throughout this text, reference is made to the roles and responsibilities of “States” or “States and Tribes.” This term or phrase is intended to mean those jurisdictions with the appropriate responsibility and authority and may also include the District of Columbia, Territories, or other governmental entities.